Project Plan

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Status

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Approved		

PROJECT IDENTITY

2018/HT, Cascar Group
Linköping University, Dept. of Elecrical Engineering (ISY)

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Contents

Document history **5**

1 Client **6**

2 Project Overview **6**

2.1 Goal and Purpose 6

2.2 Deliveries 6

2.3 Limitations 7

3 Phase Plan **7**

3.1 *Before*-phase 7

3.2 *During*-phase 8

3.3 *After*-phase 8

4 Project Organisation **8**

4.1 Organisation Overview 9

4.2 Terms of Cooperation 9

4.3 Areas of Responsibility 9

5 Documentation Plan **10**

6 Development Methodology **10**

7 Education Plan **10**

8 Internal Education **10**

8.1 Git Education 10

8.2 Visionen Positioning System Education 11

9 Client Education **11**

10 Report Plan **11**

11 Meeting Plan **11**

12 Resource Plan **12**
12.1 Human Resources 12
12.2 Material 12
12.3 Work Areas 12
12.4 Economy 12

13 Milestones and Tollgates **13**
13.1 Milestones 13
13.2 Tollgates 13

14 Activities **14**

15 Timetable **17**

16 Plan of Changes **17**

17 Quality Plan **17**
17.1 Reviews 18
17.2 Test Plan 18

18 Priorities **18**

19 Project Termination **18**

A Appendix **19**

References **19**

Document history

Version	Date	Changes	Sign	Reviewed
1.0	2018-09-26	First version.		
0.1	2018-09-20	First draft.		

1 Client

This product is developed on behalf of Professor Lars Nielsen, division of Vehicular Systems at Linköping University House B, room 2E:473, Campus Valla; tel 013-28 13 07; Email lars.nielsen@liu.se.

Customer contact is Professor Erik Frisk, division of Vehicular Systems at Linköping University, House B, room 2E:191, Campus Valla; tel 013-28 57 14; Email erik.frisk@liu.se.

2 Project Overview

The project is developed as part of the TSRT10-course at Linköping university during the autumn semester 2018, and is conducted using the LIPS-project model[1].

2.1 Goal and Purpose

The goal of the project is to design and implement a system to enable model vehicles to autonomously navigate complex traffic situations. The framework should be built so that it is easy to continue development of the system and make it possible to use the platform in other courses at Linköping University for educational purposes.

2.2 Deliveries

The documentation in Table 1 will be distributed to the customer contact during the course. If nothing else is stated the documents will be sent to Erik Frisk by email and can be printed on demand.

Table 1: Project deliveries

Name	Date
Project plan	Sept. 24
Requirement specification	Sept. 24
Design specification	
Time plan	Weekly
Status report	Weekly
Technical documentation	
User manual	
Information poster	
Promotional movie	
Project website	

Beside the above mentioned documentation, all hardware will be returned to the customer and a product presentation, with usage demonstration, will be offered.

2.3 Limitations

The system will be implemented using the vehicles provided by the customer and the equipment available in the test area Visionen. No other vehicles or systems will be tested.

The software will be developed to run on Ubuntu 16.04[2] and Ubuntu mate 16.04[3] running ROS-Lunar[4]. No other compatibility is guaranteed.

3 Phase Plan

The project is conducted according to the LIPS-model which separates the project into three different phases; *before*, *during* and *after*.

3.1 *Before*-phase

During the *before*-phase the group is assembled and receives the project directives from the customer. This is then converted to a requirement specification which in turn is presented to the customer along with a project plan and timetable. When the group and customer has reached an agreement on the content of these documents, the project can proceed to the next phase.

3.2 *During*-phase

After completion of BP3, the project group focuses on implementation and fulfilment of the requirement specification in order to complete BP5 which is the major decision point for the compliance of the resulting system.

3.3 *After*-phase

After BP5, the project enters the after phase. During this phase the following documents are constructed and submitted:

- Technical report about the system
- Concluding study
- Poster presentation of the project
- Web page with project information
- Promotional video illustrating the application of results of the project

4 Project Organisation

The project consists of 8 group members, 1 client, 1 customer contact and 2 supervisors. The client and customer contact is described in section 1. The supervisors are described briefly in section 12.1.

4.1 Organisation Overview

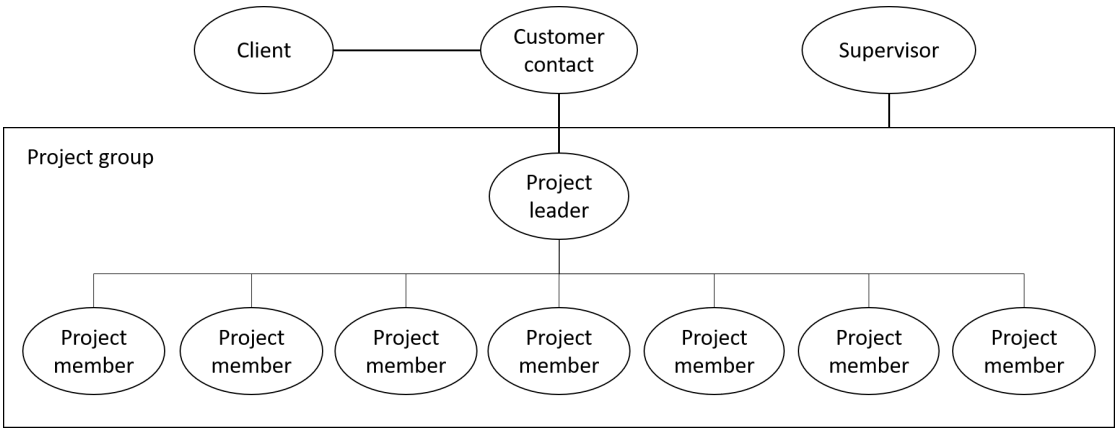

Figure 1: Organisational structure of the project.

4.2 Terms of Cooperation

The project member have agreed on an internal contract on how to behave and how to resolve conflicts.

4.3 Areas of Responsibility

The project members each have specific roles in the group. See Table 2 for the full list. During the project the group members will take on more responsibilities closely related to what they will be working on.

Table 2: Project roles

Responsibility	Name
Project Leader	Andreas Lundgren
Documentation	Julius Kokko Ekholm
Software	Adam Ahlgren
Testing	Karl Gudmundson
Software	Anton Kullberg
Design	Jonathan Hanses
Information	Andreas Larsson
Hardware	Sten Magnusson

5 Documentation Plan

The documentation will consist of the deliveries described in section 2.2. It will be written concurrently with the implementation of the project as to allow for the most current documentation at all times.

6 Development Methodology

Development of the project will be split into different parts, some low-level like vehicle control and some high-level like decision making. The project will mainly be written in Python with complement in C/C++ if needed. The git repository will be kept as clean as possible with merges to master only being done by the software team after a merge request is created and it has been reviewed. In this way we can make sure the master branch only has meaningful commits.

7 Education Plan

Education will take place concurrently with the project as more knowledge is required. Several pilot studies will need to be done to gather the necessary skills and technical knowledge before implementation begins. One lecture about how to work in a project is also provided as part of the course.

8 Internal Education

In order to distribute the collected knowledge of the group, internal education will be held during the ongoing of the project. Educational topics include, but are not limited to, introduction to Git and introduction to the Visionen positioning system.

8.1 Git Education

Git is used during the project to utilize version handling of code and documents. Members of the group with good experience of Git will educate the rest of the group members in order to achieve necessary Git-knowledge from all project members.

8.2 Visionen Positioning System Education

LiU build the Visionen arena in 2017 in order to provide space and tools for various projects and courses, primarily in the division of Automatic Control. The positioning system in Visionen provides object localisation and projection abilities. Due to the recent inauguration of Visionen, interaction with the control system demands a tutorial in order to provide sufficient foundation for the group to implement systems for interaction between the Cascar and Visionen positioning system.

9 Client Education

During the phase of project delivery to the customer, the group educates the client about how the system works and how to operate the system. A user documentation is provided with the system which contains everything the client needs to know about how the system works and how to use the system.

10 Report Plan

Type	Written by	Sent to	Purpose	Format	Delivered
Status report	Project Leader	Client	Inform the client about finished, ongoing and upcoming activities, as well as possible problems	Email and Excel	Weekly
Time report	Project group	Client	Update the time plan	Time plan template	Weekly

11 Meeting Plan

In order to ensure that work flow and deadlines are met, the group will have meetings twice a week. In addition to the internal group meetings, the project leader will meet with the client's customer contact once a week in order to ensure that the work progress is satisfying.

12 Resource Plan

Chapter describing how the different resources accessible for the group will be managed.

12.1 Human Resources

In addition to the group members, two supervisors are available for the group, Pavel Anistratov and Björn Olofsson. These two can assist the group in terms of knowledge and tips about implementation, but are not supposed to do any implementation.

12.2 Material

The group is provided with hardware in terms of 3 modified RC-cars with attached Raspberry Pi's as well as a laptop with Ubuntu 16.04 installed. These is supposed to be sufficient supply in order to complete the project and achieve the requirements of the system. If additional components are requires or desired, the client is subject to providing that if cost of the components are reasonable compared to the value of the system and the benefits of the additional components.

12.3 Work Areas

A project room is provided to the group by the client. The project room contains a computer for each group member as well as a simple lunch area. The project room is shared with another group in the course. In addition to the project room, access to Visionen is granted which allows full scale testing of the system.

12.4 Economy

The project is allowed a total of 1920 hours of work. These hours are to be divided in such a way that all requirements of priority 1 in the requirement specification are met. The ambition is that each project member has the same amount of hour invested at the end of the project.

13 Milestones and Tollgates

Several milestones and tollgates will be used to structure the project. By having clear goals the work will not stagnate and hopefully all bottlenecks can be avoided.

13.1 Milestones

The following milestones were chosen for the project:

Nr	**Milestone**	**Deadline**
1.	Follow trajectory.	2018-10-30
	Given a trajectory, the vehicle is able to follow the trajectory and adjust its position from the position feedback, thus minimizing the error value and providing a smooth movement.	
2.	Functional Simulation Environment.	2018-10-30
	The simulator uses the dynamic model of the vehicle in order to give the same output as the vehicle itself would do while driving. The output consists of position, velocity and orientation data.	
3.	Platooning.	2018-11-13
	The vehicle can be a part of a platooning mission as both leader and follower.	
4.	Roundabout driving without other vehicles.	2018-11-20
	The vehicle can perform a roundabout mission without other vehicles or dynamic obstacles in the roundabout.	
5.	Roundabout driving with other vehicles.	2018-12-04
	The vehicle can perform a roundabout mission with other vehicles or dynamic obstacles in the roundabout.	

13.2 Tollgates

The following tollgates were chosen for the project:

Nr	Description	Date
1.	Approval of requirement specification and project plan	2018-09-24
2.	Approval of design specification	
3.	Approval of final delivery	2018-12-17

14 Activities

Activities are used to find all the different parts of the project and give them an estimated time of completion. Furthermore, the activities are used to find the chain of dependency that all the different activities have to each other.

Nr	**Activity**	**Subsystem. Description**	**Dependency on other activities**	**Estimated time (h)**
1.	System configuration	General. Configure the car, establish basic communication with ROS and VPS.		12h
2.	Manual drive	General. Car driving manually from external source.	1.	10h
3.	Create map	Route planner. Creating a map all the cars can relate to.		26h
4.	Manual vehicle control simulator	Simulator. Creating a simulator for manual drive (implementation of vehicle dynamic models).		22h
5.	Map representation	Simulator. Representing the created map in the simulator.	3. 4.	26h
6.	VPS simulation	Simulator. Simulating the output about location that would in the real world be done by VPS.	4.	26h
7.	Implement car model	Simulator. Create the model of the car in the simulator.	4. 12.	12h
8.	User interface	Simulator. Create a user interface for the simulator.	4.	26h
9.	Obstacle generation	Simulator. Simulate obstacles that are in the way of the cars.	5.	18h

10.	Multiple vehicle simulation	Simulator. Simulate multiple vehicles simultaneously.	7. 6. 5. 28.	22h
11.	Collision detection	Simulator. Detect collisions for the cars.	9. 10.	24h
12.	Create model	Vehicle control. Design a vehicle model.		38h
13.	Fail-safe	Vehicle control. Implement a fail-safe device .	1.	14h
14.	Velocity control	Vehicle control. Design a controller which enables the car to adjust the velocity.	1. 12. 13.	22h
15.	Follow straight path	Vehicle control. Design a controller which enables the car to follow a straight path.	14. 17.	24h
16.	Follow curved path	Vehicle control. Design a controller which enables the car to follow a curved path.	15. 18.	22h
17.	Calculate straight trajectory	Motion planner. Calculate a straight trajectory between two points taking the map in consideration.	3.	30h
18.	Calculate curved trajectory	Motion planner. Calculate a curved trajectory between two points taking the map in consideration.	17.	30h
19.	User Interface	GUI. Create a graphical user interface.		30h
20.	Send information	GUI. Send information from the GUI to the vehicles.	19.	14h
21.	Mode Selection	GUI. Send commands to the vehicle from the GUI to select mode, e.g. platooning, car takeover.	2. 20.	10h
22.	Represent feedback	GUI. Represent feedback from the vehicles in the GUI.	19.	12h
23.	Show map	GUI. Show map and cars in the GUI.	3. 19.	18h
24.	Create route	GUI. Make a route that the car will follow.	23. 20.	18h
25.	VPS data collecting and processing	Vehicle Perception. To enable data from VPS to be gathered and processed for further use.	1.	10h

26.	LIDAR data collecting and processing	Vehicle Perception. To enable LIDAR data to be gathered and processed for further use.	1.	4h
27.	Car communication	Vehicle Perception. Enable communication between cars.	1.	10h
28.	Identify cars	Vehicle Perception. Identify all autonomous cars in the nearby area.	25.	10h
29.	Identify static objects	Vehicle Perception. Identify all static objects in the nearby area.	25. 26.	10h
30.	Model intentions	Behavioral Decision Making. A car takes other cars intentions into account when driving.	33.	30h
31.	Model platooning	Behavioral Decision Making. Model the platooning scenario in terms of how decisions should be taken.	16.	30h
32.	Model roundabouts without other vehicles	Behavioral Decision Making. To enable the cars to drive in a roundabout, without other cars interacting.	16.	30h
33.	Model roundabouts with other vehicles	Behavioral Decision Making. To enable the cars to drive in a roundabout, with other cars interacting.	32.	30h
34.	Find route between two points	Route Planning. Finds a optimized route between point.	12.	20h
35.	Education	General. Time reserved for necessary education.		80h
36.	Meetings	General. Time reserved for weekly meetings.		312h
37.	Documentation	General. Writing documents as specified in Section 2.2.		300h
38.	Test	General. Continuous testing of developed functionality.		160h
39.	Admin	General. Time and status reports.		60h
40.	Maintenance	General. Making sure hardware and software are in good condition.		40h
41.	Web page	General. Creating a web page describing the project		14h

42.	Video	General. Making a video of the performing system.		14h
43.	Poster	General. Creating a poster describing the project.		10h
44.	Presentation	General. Preparing a PowerPoint presentation.		16h
45.	Buffer	General. Time to allocate to different activities when needed.		200h

Table 5: Table describing the different activities and how they are connected to each other.

15 Timetable

See attached document.

16 Plan of Changes

If changes of conditions occur or problems in general the rest of the group and affected parties shall be informed as soon as possible. The group shall try to work around the problem to still fulfil the requirement specification. If however the group finds it impossible or too time consuming to fulfil a requirement contact with the costumer contact shall be made and a renegotiation shall be started.

To minimise the risk of not fulfilling a requirement or the need of renegotiation a requirement the group will:

- Try to early identify bottlenecks to keep up a good work flow.
- Work agile, to quickly adapt to changes.
- In a early stage do system integration to reduce the risk of unnecessary work and make sure the system design is reasonable.

17 Quality Plan

To ensure the quality of the work and product. The members of the group will perform test continuously and bigger tests will be performed at the milestones. The results of

the tests will be documented.

Documents and code will be reviewed. The group have a agreed that the code should follow the Google code standard.

17.1 Reviews

Documents will be reviewed, to ensure that the documents will be reviewed the group have assigned a editor to be responsible for the documentation.

Code will also be reviewed, to ensure that the code will be reviewed the group have assigned two members to be responsible for the software.

17.2 Test Plan

Tests should be performed when significant parts of subsystems have been implemented. This can both be tests performed in the simulator and in Visionen. The member responsible for testing will produce a document for each test that will evaluate if the implementation is sufficient. All tests will be documented and saved.

18 Priorities

To maximise the efficiency of the work, bottlenecks will be prioritised. If a bottleneck activity's finish date is delayed, it will have a impact on when the succeeding activities can be started. Therefore if a bottleneck activity's finish date is expected to be delayed, it has to be informed to the group well in time in order to figure out how to combat it.

19 Project Termination

The project is considered complete when all requirements with significance level one specified in the requirement specification are fulfilled.

A Appendix

References

[1] *LIPS – niv 1. Version 1.3.* Tomas Svensson och Christian Krysander. Compendium, LiTH, 2011.

[2] "Ubuntu 16.04" Internet: `http://releases.ubuntu.com/16.04.5/` [2018-09-24]

[3] "Ubuntu MATE 16.04" Internet: `https://ubuntu-mate.org/download/` [2018-09-24]

[4] "ROS Lunar Loggerhead" Internet: `http://wiki.ros.org/lunar` [2018-09-24]